

Normal and abnormal refraction

New ophthalmology course AFCM

Normal and abnormal



ILOs

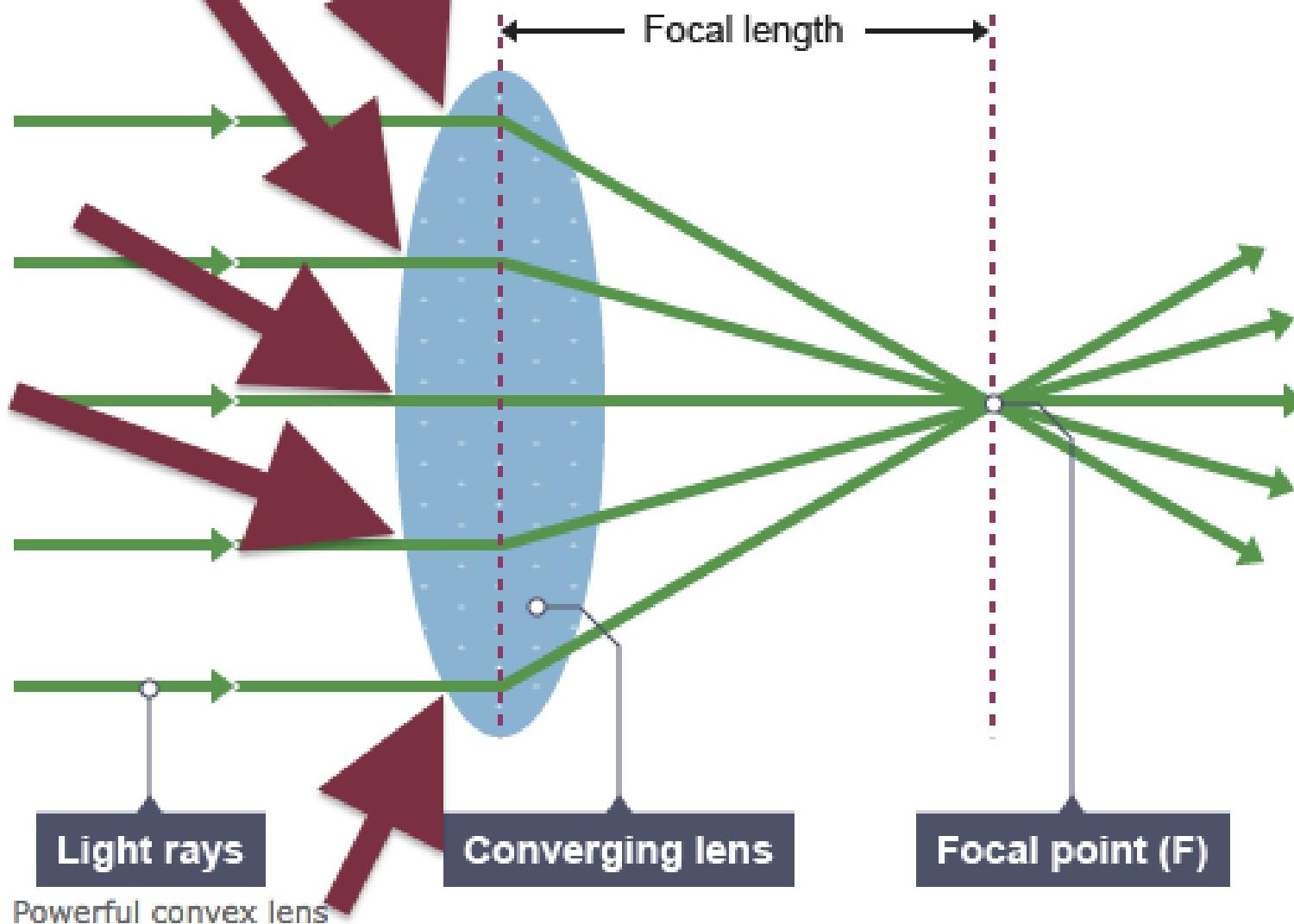
To know principle of normal refraction
To identify different errors of refraction
To put treatment plan of different errors of refraction

Definitions

- A **diopter** is the power of a lens whose focal distance is **1** meter.
- The focal distance lies between the **nodal** point and the **focal** point.

How do lenses work?

A **converging lens** uses **refraction** to bend the light rays coming out of it inwards. This has the effect of focusing the light to a point called the **focal point**.



Normal refraction state: Emmetropia

- The eye has 2 functional lenses; the cornea (**theoretical** power **42D**) and the crystalline lens (**16-18D**)
- Thus the **theoretical** power of the combined lens is around 58-60D; this creates a focal length of $100/60 = 1.67\text{cm} = 16.7\text{mm}$
- This distance (1.67cm) should **theoretically** be the exact distance between the **nodal** point of the optical system of the eye and the **sensory** layer of the retina for **emmetropia** (sharp retinal image).

Emmetropia

- We are born with small eyes (16mm) that reach the adult size (23mm) around the age of 3-4yrs.

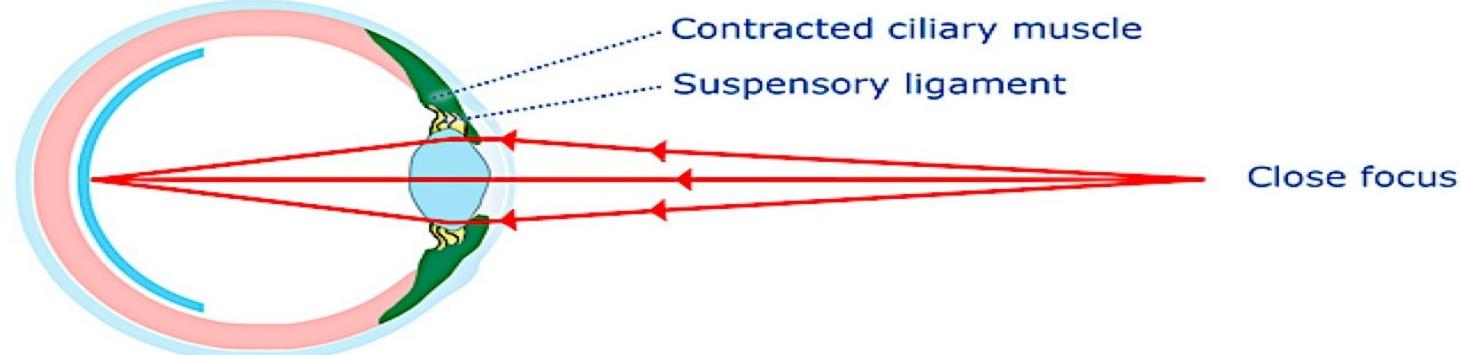
*BETWEEN BIRTH AND 4 YRS, all **children** are theoretically **hypermopes**.*

- **Some** people overgrow the final size of 23mm and become **myopes**.
- **Every 1mm increase** in axial length causes **3D of myopia**.

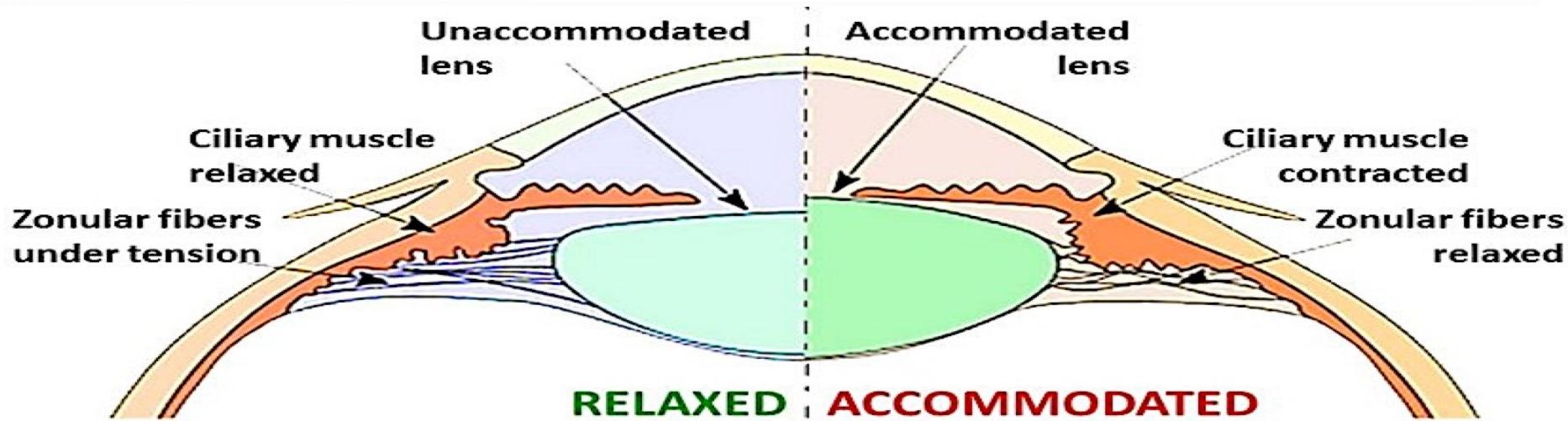
Accommodation

- Is the ability of the eye to **increase** its refractive power to see **near** objects.
- It results from the **contraction** of the ciliary muscle → **relaxation** of the suspensory **zonule** → increased lens curvature.
- Its power declines with age, and above **45yrs** it is not sufficient for **comfortable** near work.
- Amplitude of accommodation: calculated by $100/\text{near point of distinct vision in cm}$,
- e.g. If near point is 20cm, then amplitude of accommodation= $100/20= 5\text{D}$.

How the eye focuses light



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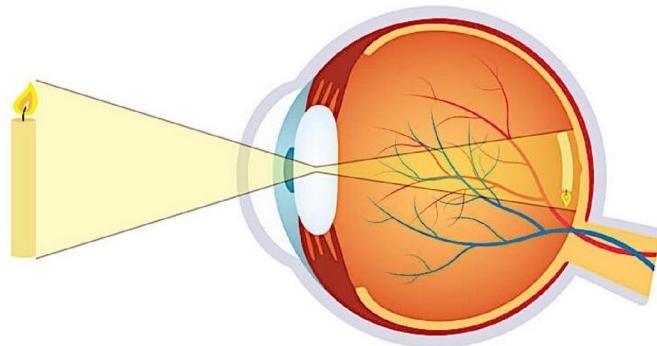
Ametropia: spherical errors

Errors of refraction occur in one of 2 general situations*

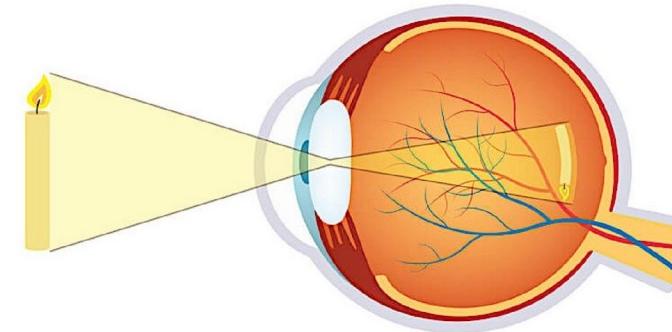
1. If the **power** of the combined lens is more or less than the **theoretical** 60D **refractive ametropia**
2. If the **distance of the retina** is more than or less than the **theoretical** 1.67cm **axial ametropia**
 - If the power of the ~~combined~~ lens is **higher** or the retina is **farther** (larger eyeball); the condition of **myopia** results
 - If the power is **lower** or the retina is **closer** to the nodal point (small eye); the condition of **hypermetropia** results
 - **Aphakia** is a form of **extreme hypermetropia** in which the crystalline lens is absent (power reduced from 60 to 42D)
 - **Pseudophakia** is the **artificial lens** implanted after cataract extraction.

*the numbers are approximate for illustration

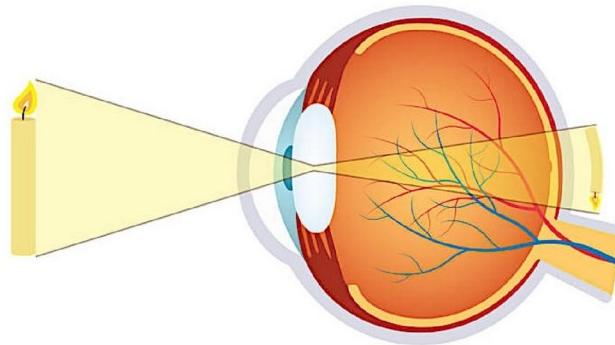
VISION DISORDERS



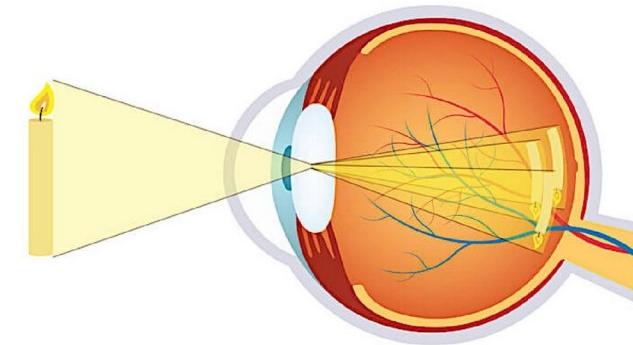
Normal vision



Myopia



Hyperopia



Astigmatism

Visual Acuity

- Normal VA is 6/6 or 20/20
- the Snellen test is a test of minimum separable acuity, it is the clinically preferred acuity test.
- A rating of 6/24 means that a letter that normally should be read at 24 METER has to be brought to within 6 METER before it is recognized by the patient.



Myopia

- Is a **refractive** condition in which **parallel** rays, with accommodation relaxed, come to focus **in front of** the retina
 - Because the **retina** is **farther** (axial M)
 - Or the combined lens is **stronger** (refractive M)
- Generally there are 2 types of myopia
 - Simple or school myopia
 - Malignant or progressive myopia

Myopia

SIMPLE

- Not genetic (excessive near work in early life)
- Starts after age of 10yrs.
- Progresses slowly
- Does not exceed -6.0D
- Arrests at age of 20yrs.
- Does not cause degenerative changes
- RD is not common
- Corrected by laser refractive surgery

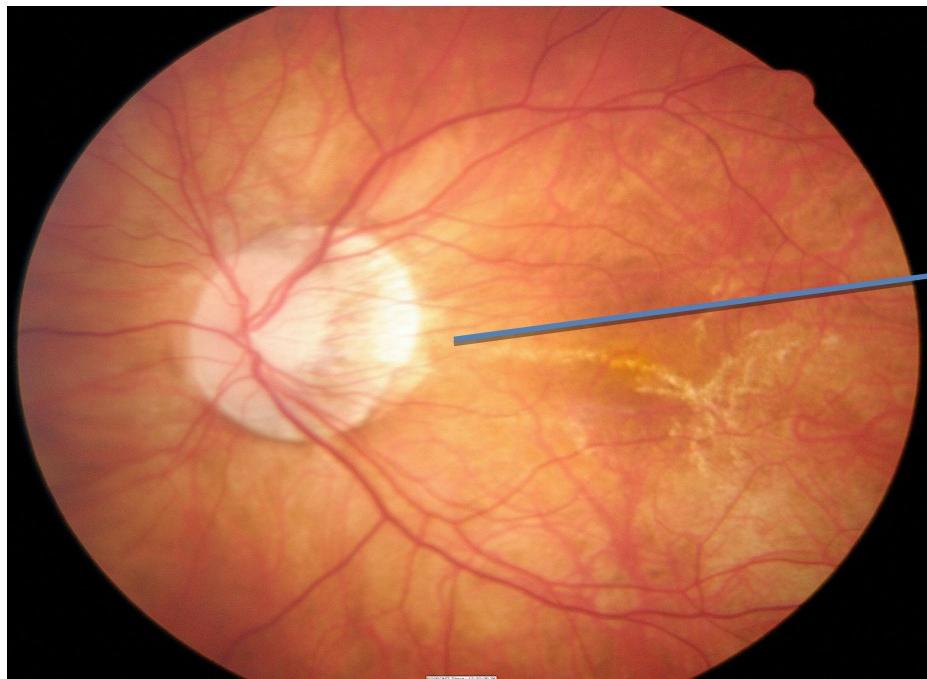
PROGRESSIVE

- Genetic (high incidence in certain races and families)
- Usually before 10yrs.
- Progresses rapidly
- Unlimited in amount
- Does not arrest at age 20
- Causes many degenerative changes in the fundus
- RD is very common
- Cannot be corrected by laser surgery

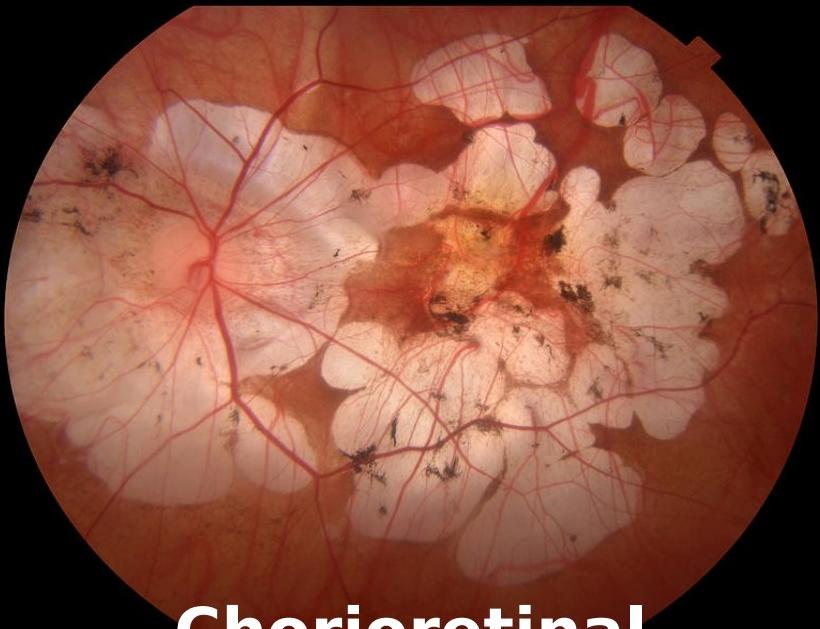
Degenerative myopia

- Large globe---apparent **proptosis**
- True exotropia
- Deep AC
- Open-angle glaucoma
- Complicated cataract
- Vitreous liquefaction---musca and flashes
- Posterior staphyloma
- Retina degenerations **flash of light**
- Choroidal degeneration

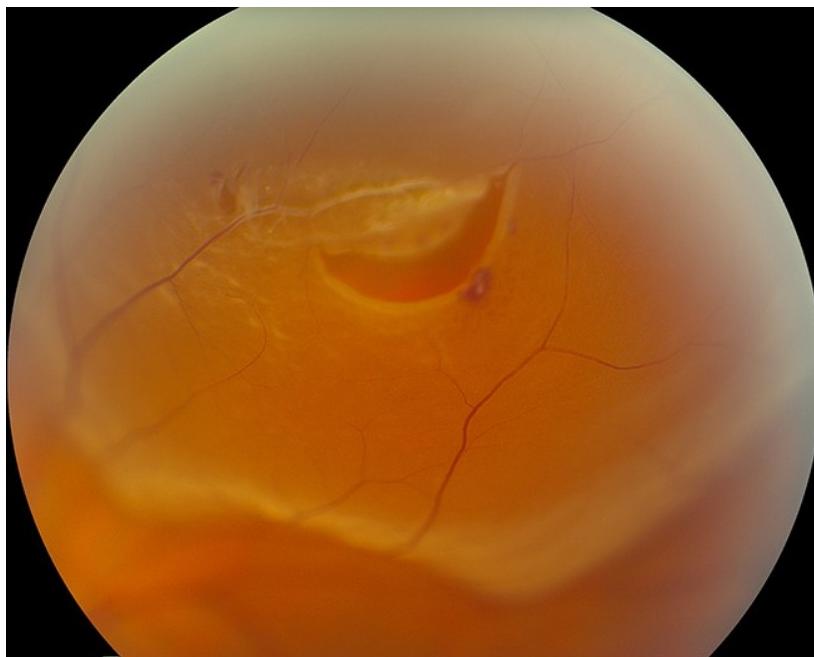
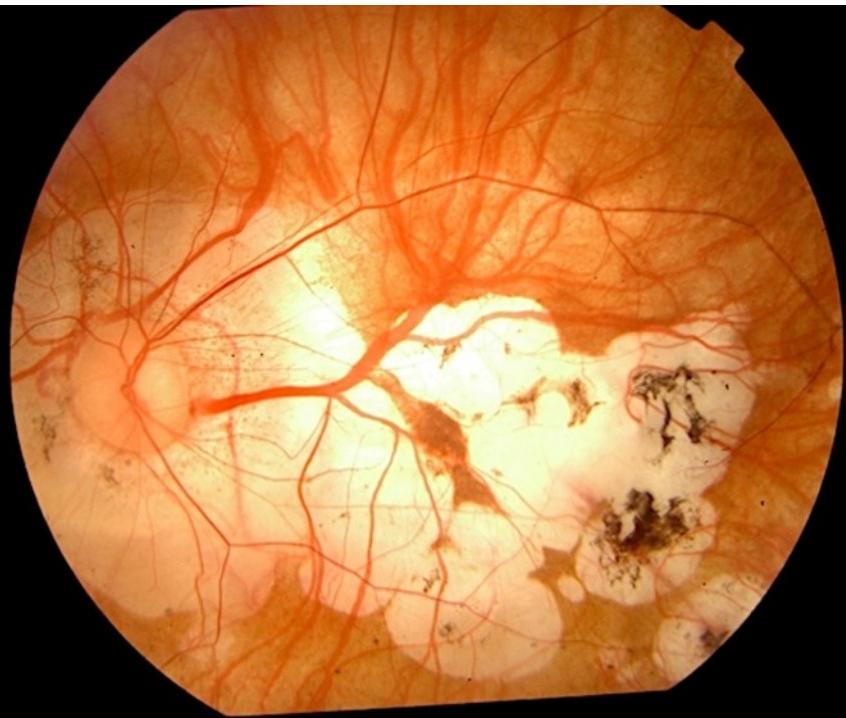
Normal fundus



**Tigroid fundus with
temporal crescent
sclera & lacquer cracks
degeneration**



Chorioretinal



**Retinal
detachment**



Myopia: correction

- Myopia is corrected by **concave (-) lenses** to decrease the power of the combined lens to 60D
- Eg. If the power of the combined eye lens is 62D, the patient is said to be -2.0 myope and is given -2.0 concave lens
- Cosmetically bad eyeglasses can be replaced by **contact lenses**
- **Refractive surgery**

Hypermetropia

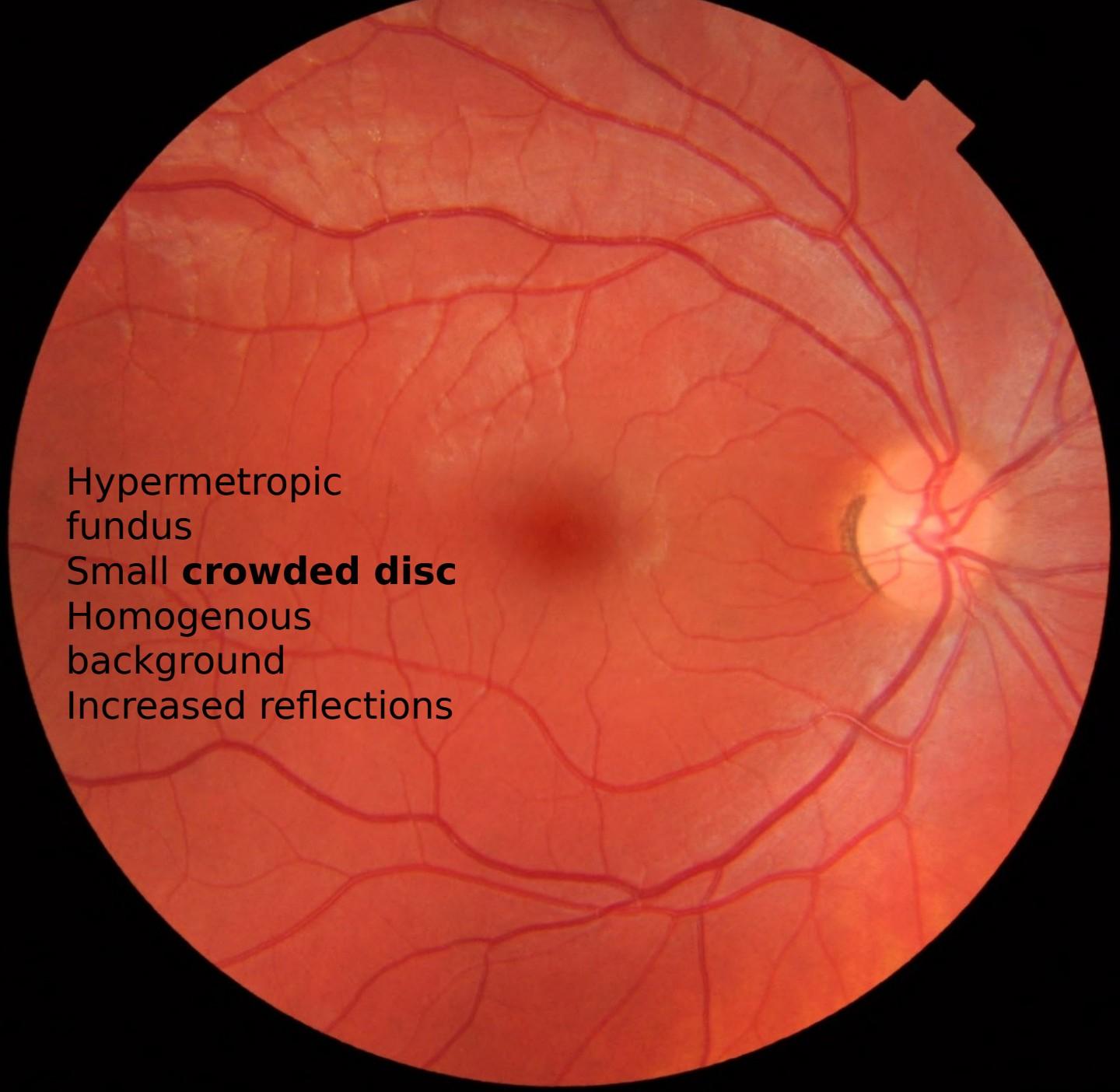
- Is a refractive condition in which **parallel** rays, with accommodation relaxed, come to focus **behind** the retina.
 - Because the **retina** is **closer** (axial H)
 - Or the combined lens is **weaker** (refractive H)
- Accommodation **can** correct hypermetropia
- The part corrected by accommodation is called **FACULTATIVE** hypermetropia and the part that cannot be corrected is called **ABSOLUTE** hypermetropia.

Hypermetropia

- Hypermetropia is a common cause of visual **asthenopia** esp. in children
- **Asthenopia** is a group of symptoms that make near work difficult including headache, blurring of vision, running of letters, desire to sleep, eye redness... etc.

Hypermetropia

- The eye is small (apparent **enophthalmos**)
- The cornea is small
- The AC is shallow
- The angle is narrow (narrow angle glaucoma)
- The retina is glistening
- The retinal vessels are tortuous
- The disc is small and crowded
- The optic cup is small



Hypermetropic fundus
Small **crowded disc**
Homogenous background
Increased reflections

Hypermetropia: correction

- Hypermetropia is corrected by **convex (+) lenses** to increase the power of the combined lens to 60D
- Eg. If the power of the combined lens is 58D, the patient is said to be +2.0 hypermetrope and is given +2.0 convex lens
- Contact lenses
- Refractive surgery

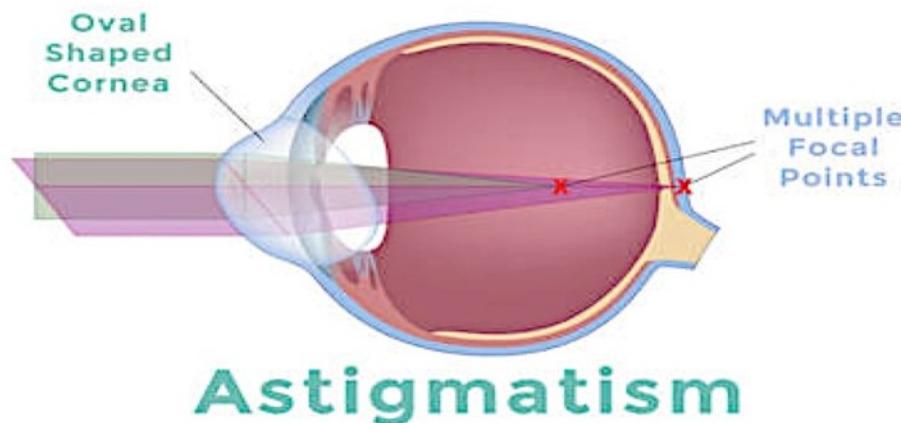
Ametropia: non-spherical errors

- Astigmatism

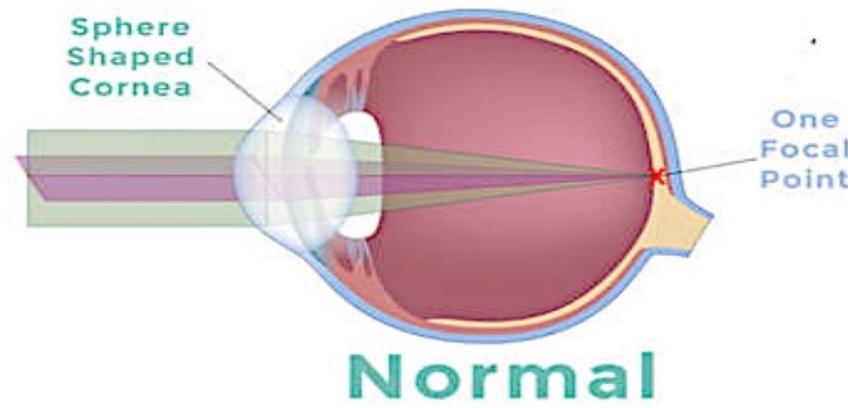
Astigmatism

- Is an error of refraction in which there is **NO** single point focus; vertical rays come to a point focus and horizontal rays come to another point focus
- It results from unequal power of the 2

What is Astigmatism?



Astigmatism



Normal

ASTIGMATISM CAN BE

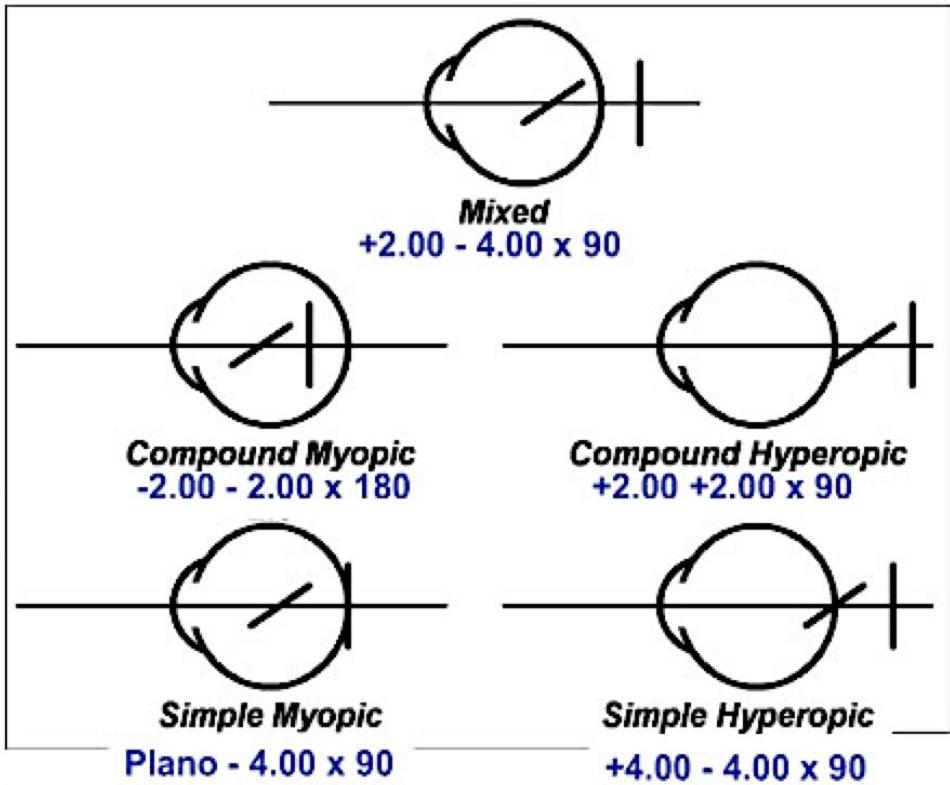
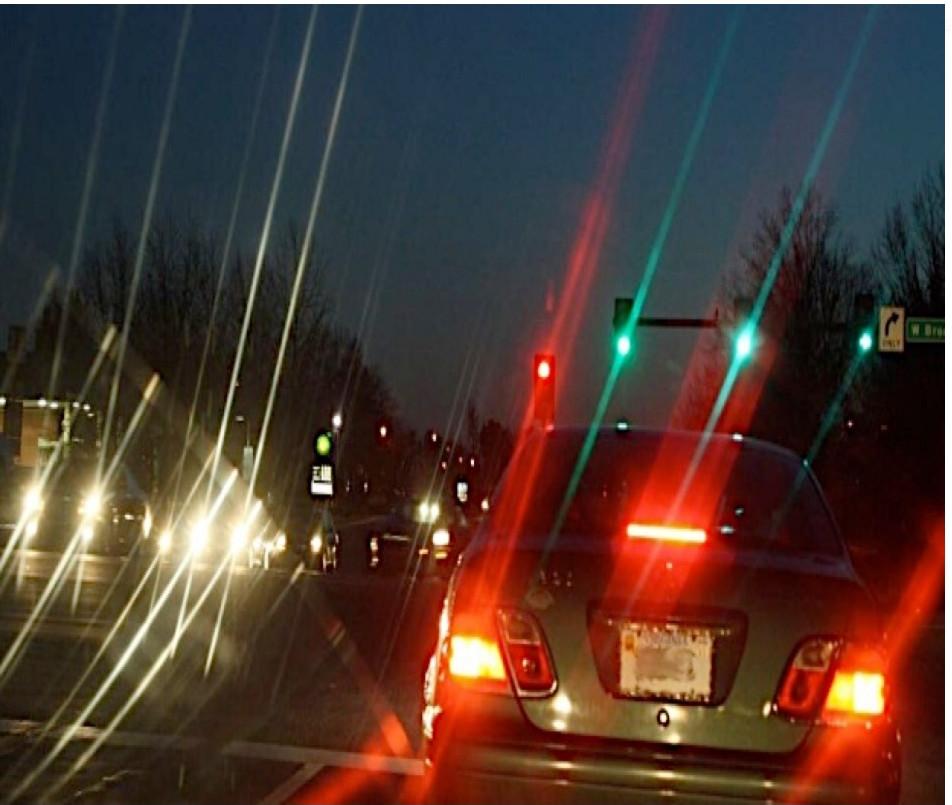
- With **the rule** or **against the rule**

Generally speaking the vertical meridian is more curved (stronger or more **myopic**) than the horizontal meridian. This is called astigmatism WITH THE RULE. The opposite situation is astigmatism AGAINST the rule

- **Vertical** or **oblique**: principal meridia can be 90/180 or 45/135 degrees

- **Regular** or **irregular** as in **keratoconus** or **corneal scars**

- cone-shaped cornea causes blurred vision and may cause sensitivity to light and glare.



- *Regular* Astigmatism is corrected by **cylindrical** lenses that work in one meridian only
- The cylindrical lens works on the meridian **perpendicular** to its axis **بالتناصف**
- Irregular astigmatism requires **hard contact** lenses for correction
- Mixed sphero cylindrical

Presbyopia Asthenopia

Hypermetrope



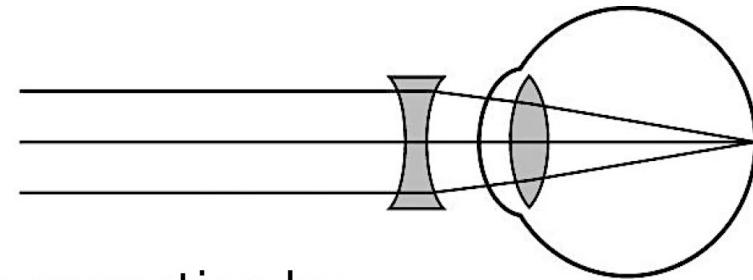
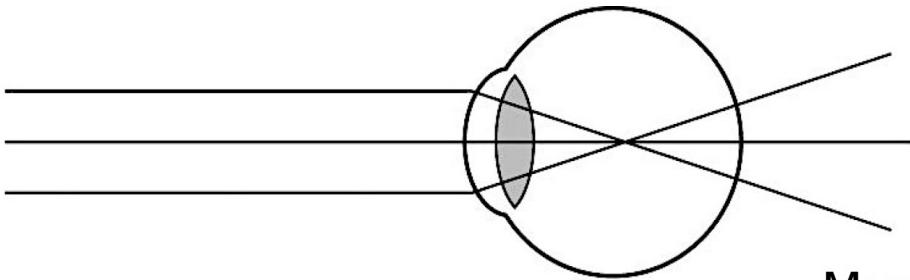
- Is **recession** of the **near** point of clear vision with age above **45yrs**. (weakness of accommodation **before** 45yrs is termed **paresis** of accommodation)
- Results from increased **rigidity** of the crystalline lens with age, which cannot change its shape and increase its power with ciliary muscle contraction in **accommodation**

Amplitude of accommodation

- Approximate amplitude/age
 - Children: 14D
 - Age 20: around 8D
 - Age 30: around 6D
 - Age 45: around 2.5D
 - Age 50: around 2D
 - Age 60: <1D

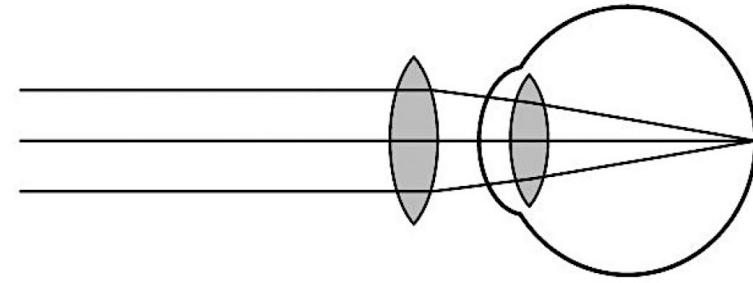
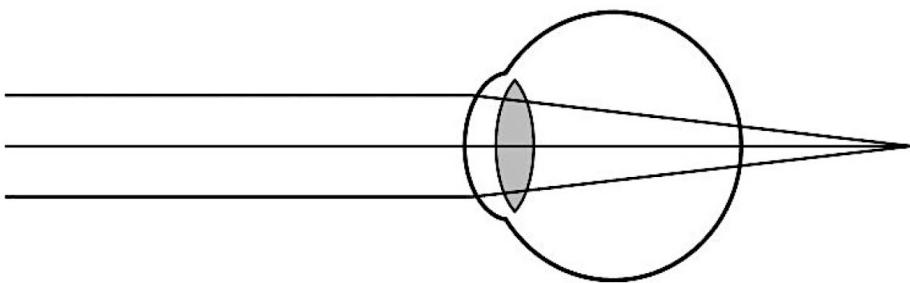
Presbyopia

- The patient needs a **reading add** to his distance glasses
- The add ranges from +1.0 to +3.0D depending on the **preferred** working distance
- To calculate the add $\square 100/\text{working distance in cm.}$ (if **working** distance is laptop-50cms, the required add is $100/50= 2\text{D}$)
- Adds greater than +3D are **not** comfortable



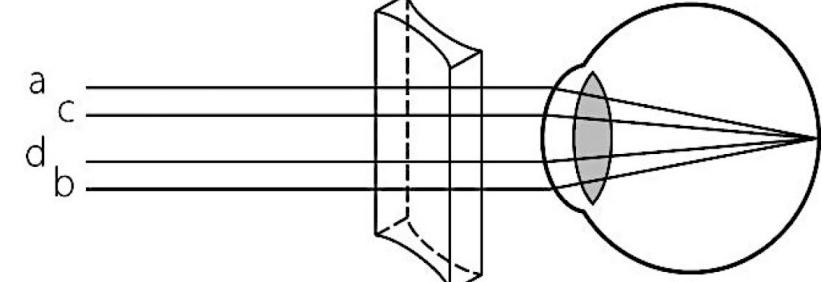
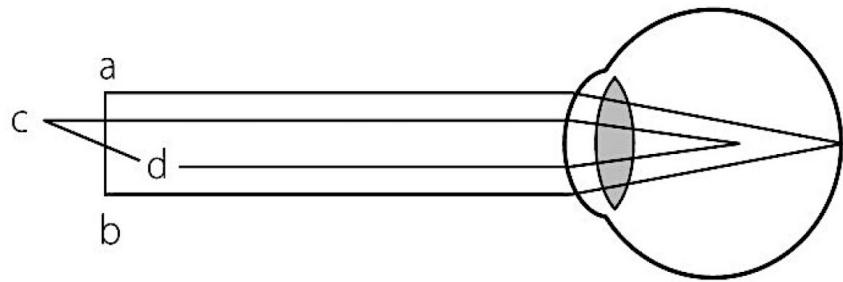
Myopia correction by
concave lens

B



Hypermetropia correction by
convex lens

D



Astigmatism correction by
cylindrical lens

F

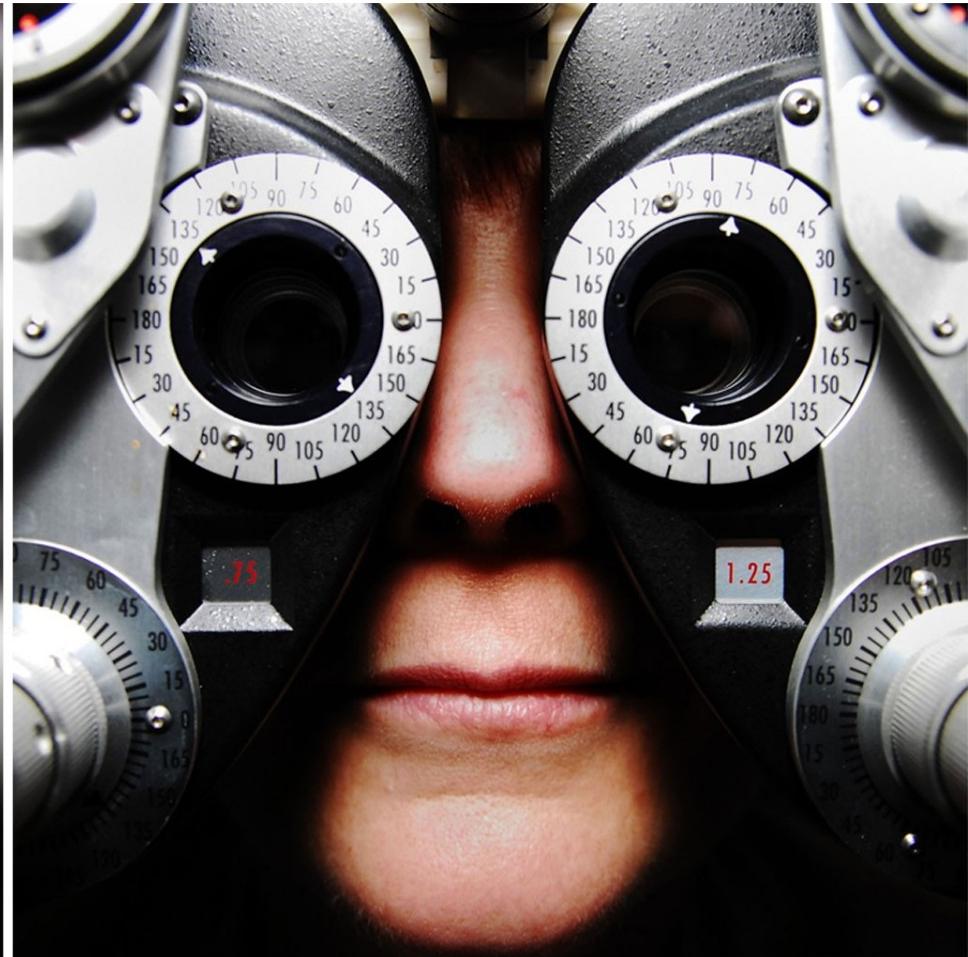
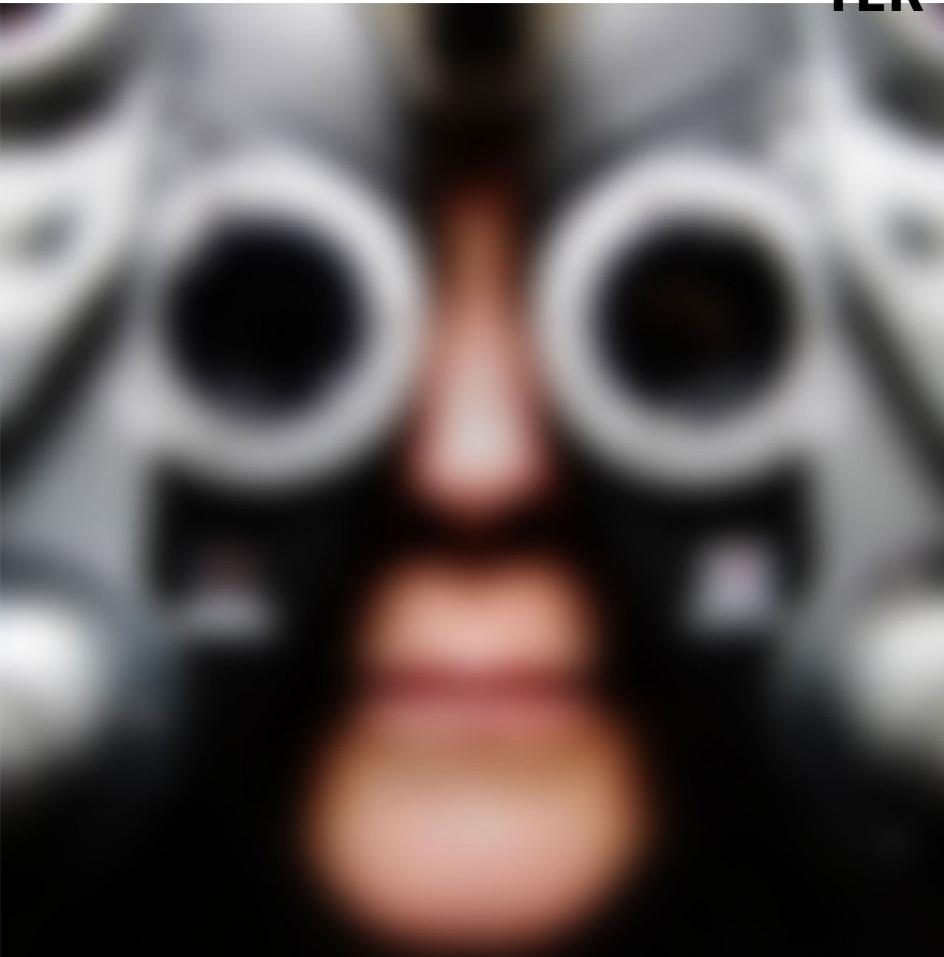
A

C

E



PHOROPTER



Contact lenses

- Are small lenses worn directly over the cornea to correct errors of refraction
- Contact lenses may be
 - Hard,
 - soft lenses
 - Semirigid
 - Cosmetic
 - Therapeutic

- The most important factor in lens wear is the **proper hygiene** otherwise complications can occur that may be severe
 - Over-wear syndrome
 - Corneal abrasions and ulcers
 - Infectious keratitis [acanthamepa](#)
 - Giant papillary conjunctivitis



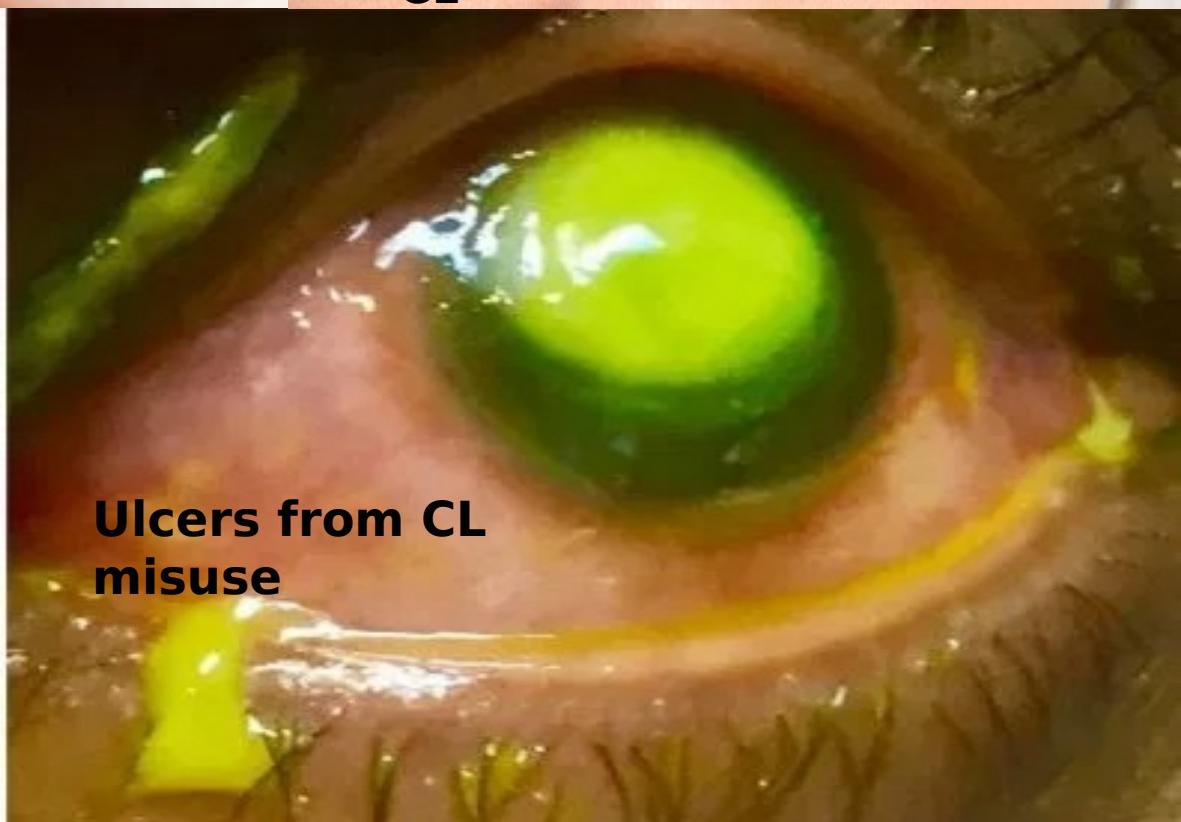
Wearing
CL



Colored
CL



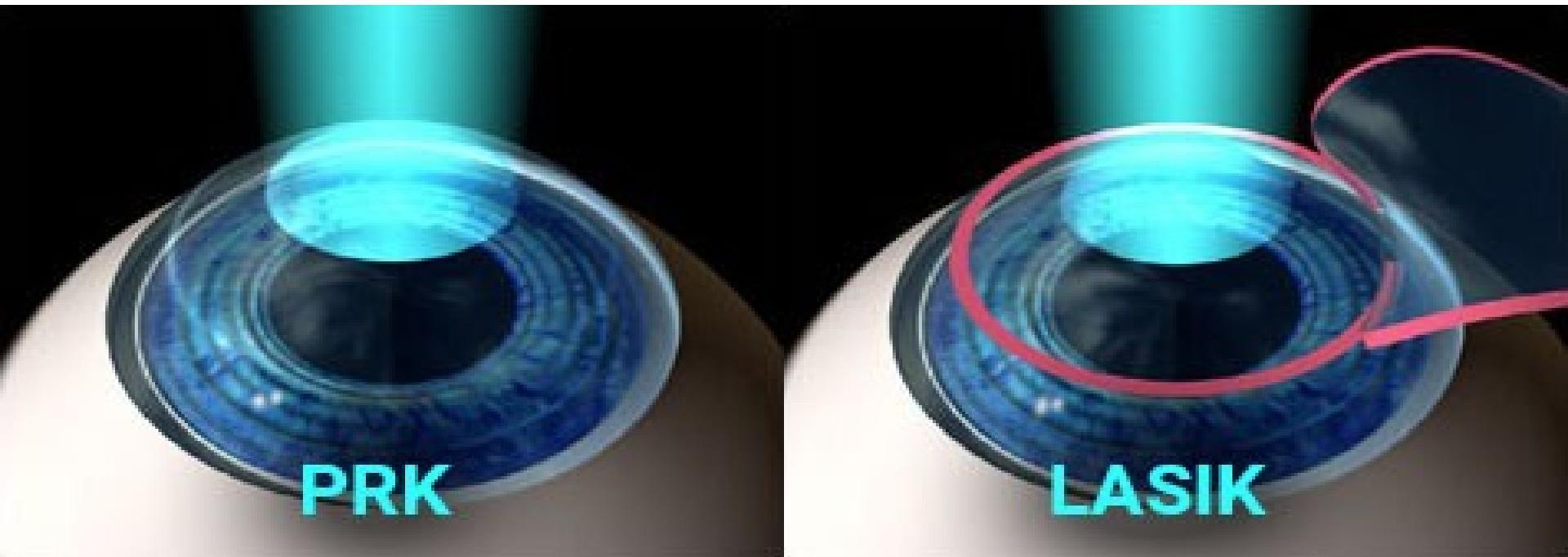
Ulcers from CL
misuse



Corneal Refractive surgery

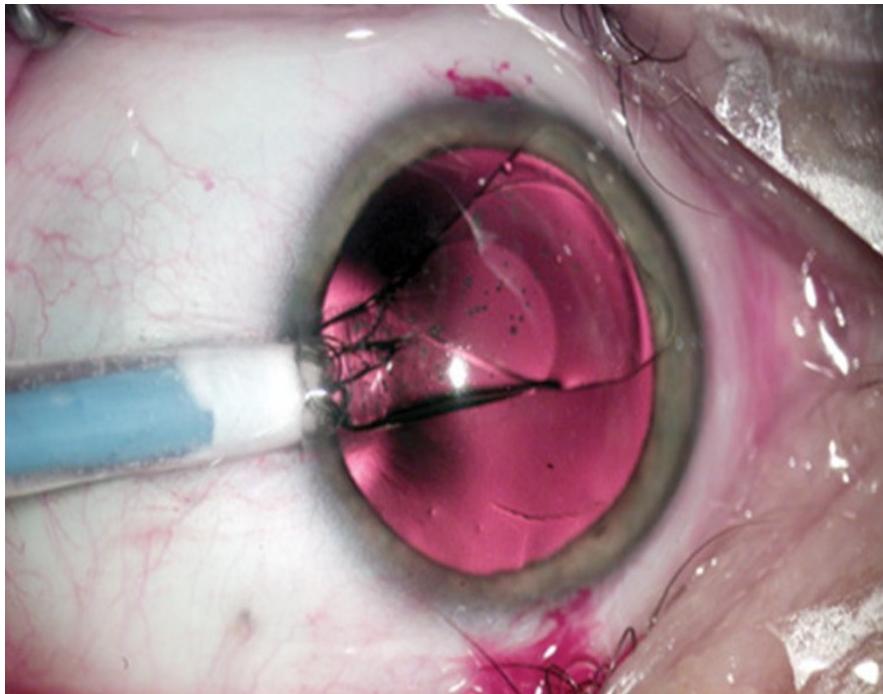
- Most refractive surgeries aim at changing the curvature of the cornea to correct ametropia
- There are general precautions for all refractive surgeries including
 - Appropriate **age** for consent and **stabilization** of error 18
أكبر من 18
 - Suitable corneal **thickness** to avoid post-ablation ectasia
 - Absence of corneal diseases, dystrophies and keratoconus
 - Absence of tear-film problems and dry eye

Corneal refractive surgery



Refractive lens surgery

Phakic IOL



Iris Claw phakic IOL

